NATIONAL BUREAU OF STANDARDS REPORT

2241

MODEL 10P 045 FRIGIDAIRE ELECTRIC DRINKING WATER COOLER

by

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MODEL 10P 045 FRIGIDAIRE ELECTRIC DRINKING WATER COOLER

manufactured by
Frigidaire Division
General Motors Corporation

by

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Heating and Air Conditioning Section
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to

Philadelphia Quartermaster Depot
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Philadelphia, Pa.

NBS

Model 10P 045 Frigidaire Electric Drinking Water Cooler

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Abstract

A specimen of Model 10P 045 electric drinking water cooler manufactured by the Frigidaire Division of General Motors Corporation was tested to determine compliance with Federal Specification 00-C-566b and Amendment 2, as modified in the Quartermaster Invitation to Bid No. QM 11-009-52-1263. Performance tests only were made as requested. The specimen, as submitted, met all requirements of the performance tests except those for the drinking-water thermostat and one of the requirements for the water regulator and valve. The latter deficiency was corrected by adjustment. The installation of a second drinking-water thermostat by a representative of the manufacturer did not permit the cooler to meet the requirements of the thermostat test.

I. INTRODUCTION

In accordance with a request from the Quartermaster Inspection Division, Chicago Quartermaster Depot, in a letter dated July 17, 1952, tests of one specimen of Model 10P 045 electric drinking water cooler manufactured by Frigidaire Division of General Motors Corporation, Dayton, Ohio, were made to determine compliance with Federal Specification 00-C-566b, with Amendment 2 dated January 21, 1952, and as modified by the exceptions in the Quartermaster Invitation for Bid No. QM 11-009-52-1263.

The performance of the specimen was determined by direct tests as described in the Federal Specification and the pertinent modifications. Special tests described herein were made to determine the performance of certain components. Inspections to determine compliance of the specimen with regard to materials and construction were not requested by the Quartermaster Inspection Division. The tests made did not require any dismantling of the specimen cooler.

II. DESCRIPTION OF TEST SPECIMEN

The water cooler specimen submitted for test was identified as follows:

NBS Test Specimen 96-52, Specification Type I, Size 10
Frigidaire Model 10P 045
Serial Number 5440829

The cooler specimen was housed in a formed, one-piece steel enclosure which constituted the back and the sides of the cooler. This housing enclosed the condensing unit compartment and evaporator section and provided structural support for the unit. The front panel could be removed, after loosening two screws at the bottom of the panel, by pulling the panel away from the cooler at the bottom and down from the recess formed by the top of the cooler. With the exception of the bubbler solenoid valve, all other controls and electric connections were accessible from the front side after the front panel was removed. It was necessary to remove the basin top of the cooler to expose the bubbler solenoid valve for replacement or servicing.

A front view of the cooler is shown in Fig. 1. Fig. 2 shows a rear view of the cooler, and the machine compartment is shown in Fig. 3. The dimensions and weight of the cooler were as follows:

Height, in.	41-1/4
Width and depth, in.	16
Weight, including wood shipping base, lbs.	140

III. TEST PROCEDURE

Tests of the specimen were made to determine compliance with the performance requirements of the following paragraphs of the specification, some of which were modified in the Invitation to Bid:

(1)	D-1, E-1, F-3a	Capacity Test
(2)	D-1a, F-3d	Peak Draw Test
(3)	D-1b, F-3b	Maximum Operating Test
(4)	D-6a	Jet of Water
(5)	D-6d	Water Regulator and Valve Test
(6)	D-10d	Refrigeration Control Test
(7)	D-10d(1), F-7	Freezing Test
(8)	D-11b	Motor Overload Protection Test
(9)	D-13a	Operation at Varying Water Pressure
(10)	D-13b	Drain Capacity
(11)	D-11a, F-3c	Overload Test

All performance tests listed above were conducted in a temperature-controlled room under the general conditions set forth in paragraph F-3a of the Federal Specification, except where the paragraph applicable for a specific test called for a different set of conditions. Temperatures were measured by means of calibrated thermocouples using an electronic, constant-balance type of potentiometer. Accuracy of this instrument was checked at intervals during the tests by means of ice-bath references. Inlet and outlet drinking water temperatures were measured by thermocouples in thin-walled stainless steel wells four inches long, mounted so that the thermocouple junctions were approximately in the plane of the exterior surface of the cooler cabinet. Water-flow rates were determined in a manner that did not interfere with the flow of cooled water through the precooler. Supply water temperatures and pressures were controlled by close-differential mechanical devices.

Additional information on the test procedure for particular tests is included with the report of the test results to further clarify how the results were obtained in cases where the specification did not provide adequate details.

IV. TEST RESULTS

The following paragraphs show the results obtained on the cooler specimen during the performance tests listed under the section on Test Procedures.

(1) Capacity Test (Paragraphs D-1, E-1, F-3a)

Table 1, which follows, summarizes the results obtained during the capacity test and compares the observed performance with the specification requirements. The entry entitled "Drinking Water Flow Rate, Corrected for 30°F Temperature Difference, gph" gives the calculated water flow rate for a 30°F difference between supply and drinking water temperatures when the actual difference during the test was not exactly 30°F. Table 1 shows that the observed capacity of the specimen exceeded the required capacity for Type I, Size 10 coolers.

TABLE 1. CAPACITY TEST OF SPECIMEN NBS 96-52

Performance Characteristics	Required Performance	Observed Performance
Ambient Temperature, °F	90	89.2
Electric Power Input, watts	--	264
Terminal Voltage	115	115
Total Current, amps	--	3.6
Drinking Water, Inlet Temp., °F	80	80.0
Drinking Water, Outlet Temp., °F	50	50.1
Drinking Water, Temp. Diff., °F	30	29.9
Spill through precooler, %	60	59.7
Drinking Water Flow Rate, observed, gph	--	11.7
Drinking Water Flow Rate, corrected for 30°F temp. difference, gph	9.0 (Min.)	11.7

(2) <u>Peak Draw Test</u> (Paragraphs D-1a, F-3d)

The specification required that 37-1/2 percent of the required hourly capacity shall be drawn off in 15 minutes. The water temperature at the beginning of the 15-minute period must not be lower than 45°F or higher than 50°F and shall not rise more than 10°F at any time during the 15-minute period. The water must be drawn off, beginning immediately after the compressor-motor cuts off in a normal cycle, in not less than three or more than six equal intervals per gallon of required draw-off capacity. The water must be drawn off at a rate of not less than 1/2 gallon per minute per bubbler. It was assumed that in accord with general requirements of paragraph F-3a, 60% of the cooled water should be allowed to flow through the precooler as water was being drawn.

For this test, the specimen was equipped with a self-closing, hand-operated stop valve adjusted to permit water to flow at a rate of 1/2 gallon per minute when opened. Water was drawn off in 54 equal samples, each consisting of a 40% portion, drawn first, and a 60% portion, drawn second. The 40% portion, representing water consumed, was poured into a container for subsequent weighing. The 60% portion was poured into a vessel of low thermal mass immediately prior to each subsequent draw. This vessel allowed the 60% portion to flow into the precooler during the time required for the entire subsequent draw.

A second thermostat was installed in the specimen cooler by representatives of Frigidaire Division in connection with the thermostat requirements. Peak draw tests were made with each of the two thermostats furnished, and compliance with peak draw requirements was observed in both cases. Using thermostat #1, a temperature rise of 8.5°F was observed, the initial outlet drinking water temperature being 46.5°F. Using thermostat #2, a temperature rise of 5.5°F was observed, with the initial outlet drinking water temperature being 49.9°F.

(3) <u>Maximum Operating Test</u> (Paragraphs D-1b, F-3b)

The specification required that the cooler should start and operate satisfactorily, and should be tested for at least 8 hours of continual operation under conditions of 110°F ambient temperature, 100°F inlet water temperature, 50°F outlet water temperature, and, it was assumed in accord with paragraph F-3a, with 60% spill through the precooler.

The cooler was operated for eight hours under the above conditions. At the conclusion of the test, the cooler was turned off and left idle for five minutes and then restarted to determine whether or nit would start satisfactorily without causing the motor overload mechanism to operate. The cooler

started and operated satisfactorily during this test. Table 2 shows the average conditions maintained during the maximum operating test.

TABLE 2. MAXIMUM OPERATING TEST OF SPECIMEN NBS 96-52

Performance Characteristics	Required Performance	Observed Performance
Ambient Temperature, °F	110	109.4
Electric Power Input, watts	--	298
Terminal Voltage	115	115
Total Current, amps	--	3.9
Drinking Water, Inlet Temp., °F	100	101.1
Drinking Water, Outlet Temp., °F	50	50.0
Drinking Water, Temp. Diff., °F	50	51.1
Spill through precooler, %	60	60.8
Drinking Water Flow Rate, observed, gph	--	6.6
Drinking Water Flow Rate, corrected for 50°F temp. difference, gph	--	6.7

(4) Jet of Water (Paragraph D-6a)

The position of the jet of water relative to the orifice, guard, and cooler basin was observed and was found to be in compliance with the specification requirements.

(5) Water Regulator and Valve Test (Paragraph D-6d)

The specimen cooler was equipped with an adjustable, automatic water-pressure regulating valve and a foot-pedal actuating an electric switch which opened the bubbler solenoid valve. The adjustment for the pressure regulating valve was accessible after removal of the front panel. The foot pedal switch also was accessible after removal of the front panel; however the basin top of the cooler had to be removed if service on the solenoid valve became necessary. The solenoid valve could be removed from the cooler without breaking the cooling unit insulation.

Observations were made of the stream height, through distance, and rate of water discharge on the specimen cooler for inlet water pressures of approximately 20 psig and 75 psig. At 75 psig inlet pressure, the solenoid valve did not open properly on the cooler. A representative of the manufacturer found the valve to be out of adjustment and corrected the difficulty. After the adjustment, the valve operated satisfactorily. The results of the observations are summarized in Table 3 below.

Water did not spurt from the bubbler of the cooler specimen when the stop valve was opened except when purging air during initial filling of the cooler. No objectionable spashing of the drinking water on the cooler top was observed.

TABLE 3. WATER PRESSURE REGULATOR PERFORMANCE
COOLER SPECIMEN NBS 96-52

Supply Water Pressure, psig	20	75
Stream Height above nozzle, in.	3-1/2	5
Stream Height above guard, in.	1/4	1-3/4
Throw Distance from nozzle, in.	3-1/2	5-1/2
Flow rate, gph	26.7	36.9

(6) <u>Refrigeration Control Test</u> (Paragraph D-10d)

The cooler specimen was equipped with a thermostat which controlled the operation of the compressor motor. The thermostat was readily accessible for adjustment and servicing when the front panel of the cooler was removed, and could be replaced without breaking the main insulation of the cooling unit housing.

Adjustment of the thermostat could be affected by turning a knob. The thermostat caused the cooler to deliver colder water when this knob was turned in a clockwise direction, and caused delivery of warmer water if the knob was turned in a counterclockwise direction. In addition, a small adjusting nut located on top of the thermostat casing could be used to change the range of the thermostat.

The specification requirement as modified in Amendment 2 stated in part:

> "Unless otherwise specified, the temperature control of the water shall be adjustable between 45°F and 55°F and shall have a differential of not more than plus or minus 5°".

This sentence has been interpreted by this Bureau for all water coolers tested for the Office of the Quartermaster General to require that the adjustment of the thermostat shall cover a range large enough to result in delivered water at control point temperatures ranging from 45°F or lower to 55°F or higher. Since the rate of water withdrawal for which these control points should result is not given in the specification, the rate of 1/2-hourly capacity has been selected with the water being drawn at equal intervals of time in batches of 12 fl. oz. each.

In the light of this interpretation, the cooler specimen did not meet the requirements of paragraph D-10d. For the rate of withdrawal mentioned above, and using the original thermostat furnished with the cooler, the average delivered water temperature at the lowest setting was 40.7°F with a maximum deviation from this average of 0.9°F, and for the highest setting of this thermostat, the average temperature was 41.8°F with a maximum deviation of 0.4°F from this average. In testing this thermostat, only the knob in front of the thermostat, and not the adjusting nut located on top of it, was used to change the range of thermostat operation.

After this thermostat was reported in non-compliance, a representative of the manufacturer installed a second thermostat. Tests of this thermostat indicated that at its lowest setting the average delivered water temperature was 41.4°F with a maximum deviation from this average of 1.1°F, and at its highest setting the average temperature was 48.2°F with a maximum deviation of 3.2°F from the average. In testing this thermostat, the knob as well as the top adjusting nut was used to change the range of thermostat operation. The representative of the manufacturer requested that the performance of the cooler specimen be judged on the basis of the second thermostat tested. As can be seen from these results, the cooler did not meet the requirements using either the first or the second thermostat.

(7) <u>Freezing Test</u> (Paragraph D-10d (1), F-7 modified)

The cooler specimen had a temperature-sensitive switch in the condenser fan circuit, which would stop operation of the condenser fan when the ambient temperature dropped below a predetermined point. This switch, in conjunction with the automatic expansion valve used as refrigerant flow control, served as protection against feezing by assuring a sufficiently high entrance pressure to the expansion valve so that it would always operate at above-freezing temperatures.

Three freezing tests, each of 48 hours duration, were made, the first in an ambient of 50°F, the other two in an ambient of 35°F. The drinking-water thermostat was shunted, and the cooler was operated under the above conditions. No freezing was observed during any of the three tests and drinking water could be drawn from the cooler at the conclusion of each test.

(8) <u>Motor Overload Protection Test</u> (Paragraph D-11b modified)

Paragraph D-11b states in part: "Motors shall be protected in case of failure of the starting mechanism or excessive overload by a thermal protective device of proper current rating,

which shall open the circuit before the motor windings reach a temperature that will injure the motor."

The cooler specimen was equipped with such a device. To determine the protection afforded, two tests were made, both in a 90°F ambient temperature, with supply water flowing steadily through the cooler at a rate slightly in excess of 30 gallons per hour. First, the power lead to the starting winding of the compressor motor was disconnected. The cooler was then energized electrically, and measurements were made of the motor running-winding resistance immediately following each cutout of the overload protector. The overload protector was allowed to function until successive resistance measurements at the time of cutout were no longer increasing and the temperature of the winding was computed on the basis of the highest resistance observed. The highest motor-winding temperature computed under these conditions was 206°F. Second, the condenser fan was disconnected, the air flow over the condenser was blocked, and the cooler was allowed to continue in operation. Under these conditions, the highest motor-winding temperature computed from resistance observations was 210°F.

Based on present accepted practice in the design of hermetic motor-compressor units, it is the opinion of this Bureau that the compressor-motor of the cooler was adequately protected against overload and against excessive temperatures caused by motor overload.

(9) Operation at Varying Water Pressures (Paragraph D-13a)

After adjustment of the bubbler solenoid valve, discussed under Section 5 of the Test Results, the cooler operated satisfactorily when connected to a water supply system at pressures ranging from 20 psig to 75 psig. The capacity test described under Section 1 of the Test Results was made with a water supply pressure of approximately 25 psig. The performance of the water regulator under supply water pressures of 20 psig and 75 psig is discussed under Section 5 of the Test Results.

(10) Drain Capacity (Paragraph D-13b)

The drainage system of the cooler specimen was apparently free of internal trappings and did not cause stoppage of water in the bubbler basin.

(11) Overload Test (Paragraphs F-3c, D-11a modified)

The cooler specimen was tested in accordance with the requirements of paragraph F-3c of the specification, which calls for 4 hours of continuous operation in 100°F ambient temperature with water drawn at the rate of 300 percent of the required hourly capacity and 60% spill through the pre-cooler. The inlet water temperature was held at approximately 80°F. The results of this test are summarized in Table 4, which follows.

The cooler operated satisfactorily and without any indication of breakdown. The temperature rise of the motor running winding was determined by the resistance method and computed by the formula given in paragraph 4.2.3 of Federal Specification CC-M-636a, dated October 29, 1951. Table 4 shows that the temperature rise of the motor winding was well below the permissible rise for totally-enclosed motors in this specification.

It is pointed out that Federal Specification CC-M-636a does not carry any reference to motors integral to a hermtically-sealed refrigeration compressor. It is believed that the coil-winding temperature rise limits for totally-enclosed type motors should serve as a guide to assist in judging hermetic motors.

The overload test, for which the results are summarized in Table 4, was inadvertently made in an ambient temperature of 90°F instead of 100°F as required by the specification. However, since the temperature rise of the motor windings was more than 30C below the permissible maximum, it is very unlikely that a rise of 10F in the ambient temperature would cause the specimen to fail the overload test.

TABLE 4. OVERLOAD TEST OF SPECIMEN 96-52

Performance Characteristics	Required Performance	Observed Performance
Ambient Temperature, °F	100	89.8
Drinking Water, Inlet Temp., °F	--	79.9
Drinking Water, Outlet Temp., °F	--	68.3
Ratio of Drinking Water Flow to Required Capacity, %	300	300
Spill through precooler, %	60	60.0
Electric Power Input, watts	--	262
Terminal Voltage	115	115
Temperature Rise of Motor Windings, °C	65* (maximum)	33.8

* Permissible temperature rise for totally-enclosed fractional-horsepower motors in Federal Specification CC-M-636a.

V. CONCLUSION

The cooler specimen, as submitted, met all the specification requirements of the performance tests, with the exception of the thermostat test and part of the water regulator and valve test. Adjustment of the bubbler solenoid permitted the specimen to meet the water regulator and valve test. However, installation of a second thermostat did not result in compliance with the requirements of the thermostat test.

FIG. 1

FIG. 2

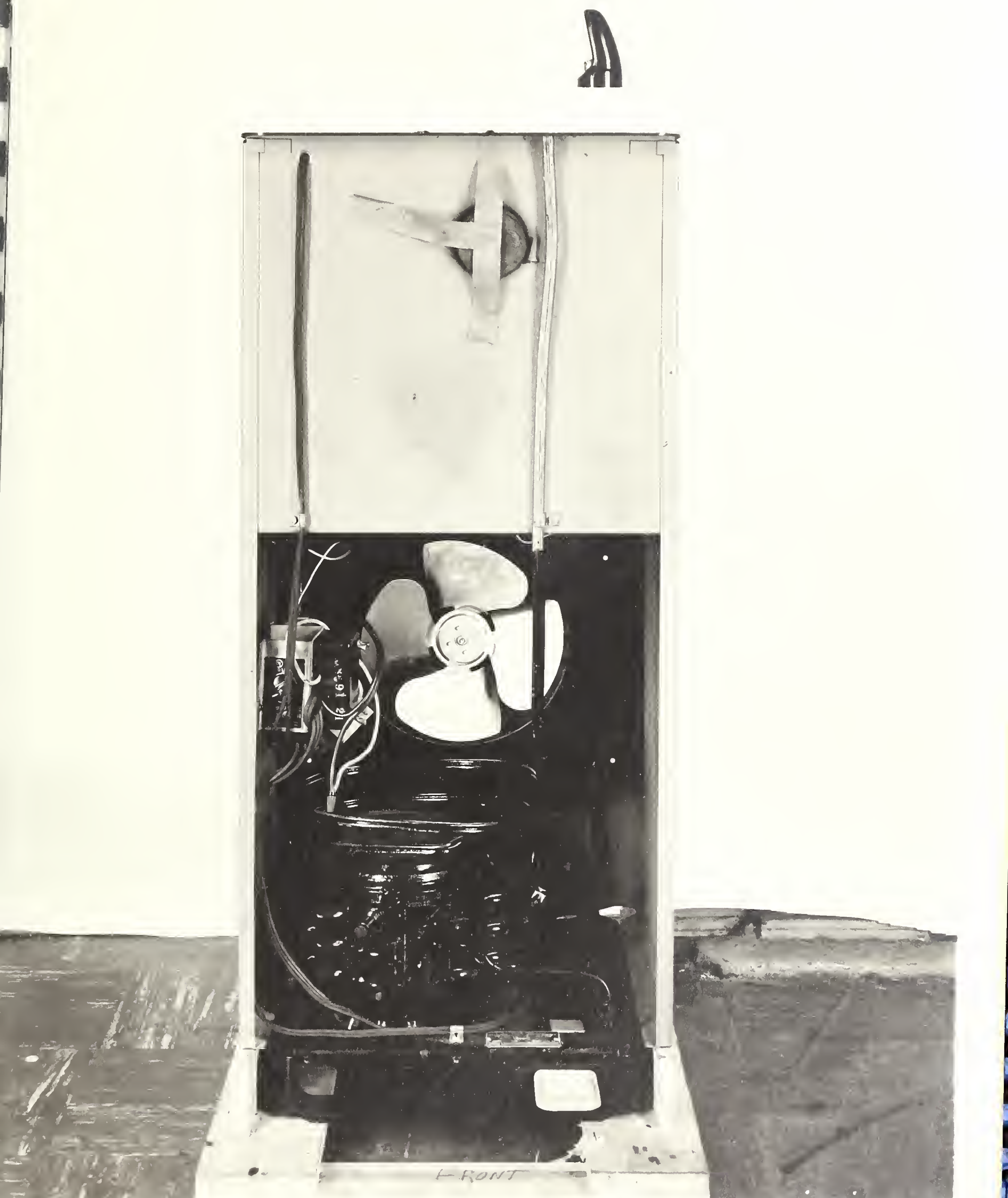

FIG. 3

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